



Role of Doppler Ultrasound and Percutaneous Transluminal Angioplasty in Early Diagnosis and Management of Peripheral Artery Disease

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Abstract

BACKGROUND: Peripheral arterial disease (PAD) denotes vascular disorder which peripheral artery's obstruction or constriction is found. PAD with diabetic history is more susceptible to ischemic ulcer than PAD with no diabetic. The presence of Diabetes mellitus (DM) in PAD can speed up 4 times greater risk of developing Critical Limb Ischemia. In our hospital, difficulty performing extremity perfusion assessment is often found because those examinations are not available, so possibility of PAD can be missed. Therefore, optimalization use of Doppler Ultrasound (DUS) is important in our case.

AIM: The purpose of our case writing is to give information about substantial parameter of DUS in determine presence of PAD and define the role of percutaneous transluminal angioplasty (PTA) in PAD. The earlier PAD discovered, faster further treatment conducted, especially PTA.

CASE REPORT: A 65-year-old female patient with intermittent left calf pain for 7 months who went to internal medicine outpatient has reported. She has history of type 2 DM and significant hyperlipidemia. On physical examination, vital signs revealed normal value. Body mass index was 28 kg/m². Resting ankle-brachial index (ABI) measurement was 1.14 and 1.12 at the right and left dorsalis pedis, respectively. DUS showed spectral narrow, reversal flow and no clear spectral window in superficial femoral artery. There are clear spectral window, spectral narrow, and reversal flow in poplitea artery. No clear spectral window, no spectral narrow, and no reversal flow in anterior tibia artery. Clear spectral window, reversal flow, and no spectral narrow are appear in posterior tibia artery. Arteriogram of left inferior extremity showed middle part partial stenosis of anterior tibia artery. Dilatation with standard balloon for 1 min was done. After that, no stenosis in same location and she wasn't feel calf pain again.

CONCLUSION: Compared with two other parameters, reversal flow in DUS is most important parameter to establish presence of stenosis. PTA is adequate to give revascularization stenosis in PAD.

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Introduction

Peripheral arterial disease (PAD) is defined as vascular disorder which peripheral artery's obstruction or constriction is found [1], [2]. Mostly, obstruction of blood supply in PAD is caused by atherosclerosis [1]. Clinical finding of PAD assorted from asymptomatic, weakness in the legs, foot ulcers, gangrene, and critical limb ischemia (CLI) [2], [3]. Early assessment and appropriate therapy of PAD is essential to preserve quality of life, accelerate ulcer healing and diminish the risk of limb amputation [3], [4].

PAD is more found in male and higher in increasing age. PAD's prevalence is 4.3% in people over 40 years old [4], [5]. Diabetes mellitus (DM) is known as one of major risk factor for PAD [6]. The World Health Organization forecasted an increasing number of DM patient in Indonesia in 30 years, which were 8.4 million into 21.3 million [7]. PAD prevalence in patients with DM ranging from 9.5–13,6%, which is far higher than the general population of 4% [6].

The presence of DM in PAD can speed up 4 times greater risk of developing CLI [6], [7]. CLI is a clinical syndrome related with PAD which is characterized by chronic ischemic pain particularly in rest or a tissue loss condition, such as wound or gangrene that does not heal over a period of at least 2 weeks [5], [6]. Rutherford classification determines PAD based on clinical presentation and objective test, such as Doppler Ultrasound (DUS), Ankle Brachial Index (ABI) and pulse volume recording [8].

Based on Algorithm of Diagnostic Testing of Suspected CLI by American Heart Association (AHA) Guideline in 2016, if we found nonhealing wound or gangrene with normal ABI result, perfusion assessment is recommended furthermore. Unfortunately, Toe-brachial index (TBI) with waveform, TcPO₂ (transcutaneous oxygen pressure) and skin perfusion test are not available in our hospital, so we determine early assessment of PAD with DUS.

The purpose of our case writing is to give information about substantial parameter of DUS in

determine presence of PAD and define the role of percutaneous transluminal angioplasty (PTA) in PAD. Although DUS is operator dependent, if we can do it properly, possibility early vascular occlusion is never missed. The earlier PAD discovered, faster further treatment conducted, especially PTA. It has been generally used to get over PAD and is suggested as preference management compared open surgery [9], [10], [11], [12], [13].

Case Report

We report the case of a 65-year-old female patient with intermittent left calf pain for 7 months who came to internal medicine outpatient of PKU Muhammadiyah Gamping Hospital in Yogyakarta. Pain was felt from left groin to the left toe. The pain was felt especially during activity and relieved by rest. She also complained about swollen at left toe. She had amputated of left third and fourth toe 1 year ago caused by gangrene.

Our patient had type 2 DM history since 10 years ago. Glibenclamide and metformin was given to our patient. Unfortunately, she discontinued the oral medication. Besides that, she had hyperlipidemia for 10 year ago, but she had not consumed medicine regularly. She is also had hypertension and got ACE inhibitor medication. 1 year ago, left third toe and fourth toe were turn to black and had ulcer or gangrene, so amputation was done by surgeon specialist. No family member that has similar symptom history, but the patient's father had diabetes history.

Vital sign examination revealed a general state of weakness with Glasgow Coma Score (GCS) 4/5. Blood pressure were 150/100 mmHg. Pulse, respiratory rate and axillary temperature were normal. Pain scale examination showed score 5 based on Visual Analog Scale, it means moderate pain. The patient's body weight was 77 kg; body height was 153 cm, with body mass index showed 33 kg/m².

Examination of head and neck showed no anemic in conjunctiva, no icteric in sclera, no dyspnea and no cyanosis. There was no increase of jugular venous pressure or any enlargement of the neck lymph nodes. The chest and cardiac examination revealed normal result. Normal bowel sound, tympanic percussion and normal palpation were found in our patient. Spleen and liver were not palpable.

Extremity examination confirmed swollen in the left foot and ischemic ulceration (Figure 1). Left foot turn to black. She denied any previous trauma and fever. Resting ABI result showed 1.14 at right toe, 1.12 at left toe, both of these means normal. Whereas TBI value showed 0.9 at right toe, 0.5 at left toe, it means abnormal at left toe and normal at right toe. Arterial



Figure 1: Swollen and rubor in the middle of left calf until to toe. Our patient is planned for hospitalization. Then, DUS examination was done as mentioned below

pulsation was normal in femoral, popliteal and posterior tibial artery, but pulsation of anterior tibial artery was diminished. Peripheral oxygen saturation examination in the left foot digiti I, II and V were 83%, 84% and 85% respectively, while in the left foot digit III and IV cannot be examined caused by amputated history previously. Based on history finding and physical examination, our patient was diagnosed to have Rutherford-Baker classification stage 2.

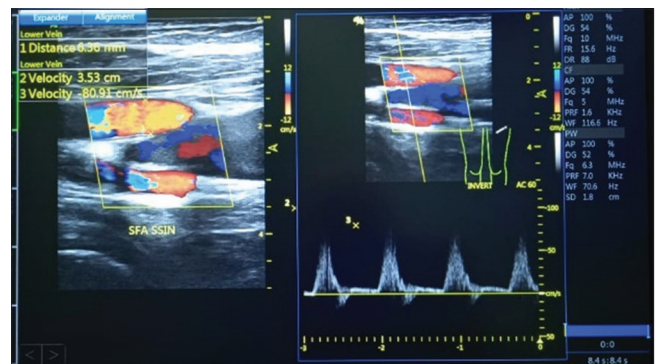


Figure 2: No clear spectral window in superficial femoral artery

DUS of femoral superficial artery showed there were spectral narrow and reversal flow finding, but no clear spectral window in it (Figure 2). Clear spectral window, spectral narrow and reversal flow were revealed in DUS of poplitea artery (Figure 3). Whereas DUS of anterior tibial artery showed no clear spectral window, no clear spectral narrow and no reversal flow

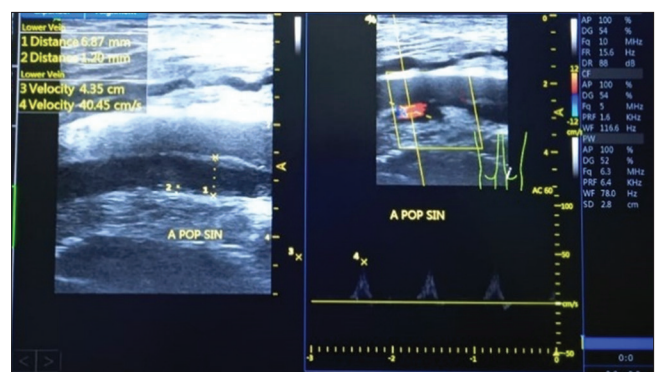


Figure 3: There were many plaque in poplitea artery. No stenosis in it

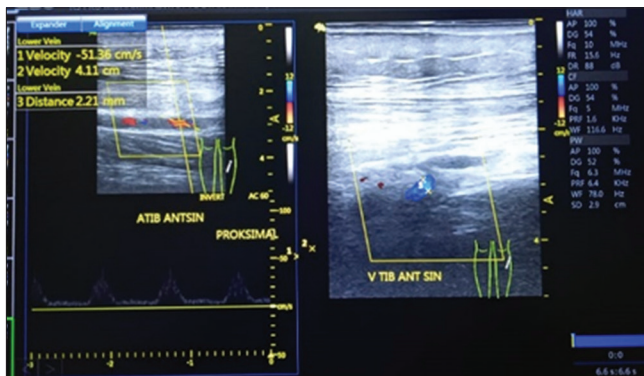


Figure 4: There were many plaque in anterior tibia artery. No clear spectral window, no spectral narrow and no reversal flow

(Figure 4). Furthermore, clear spectral window and reversal flow were appeared in DUS of posterior tibial artery, but no spectral narrow in it (Figure 5).



Figure 5: Clear spectral window and reversal flow in posterior tibial artery

Our patient was also planned for arteriography followed by PTA. We asked suggestion from cardiologist about our case. Antiplatelet infusion was given 3 days before PTA. 1 day before PTA, it was stopped and planned for PTA. After got informed consent from our patient, arteriography and PTA was done at catheterization laboratory (cath lab) at PKU Muhammadiyah Gamping Hospital (Figure 6). Our team were Interventional Radiology team which do invasive minimal procedure to diagnose the presence of vascular occlusion, stenosis or other causes that can causes pain in the leg. Arteriography finding in our patient was partial stenosis of proximal of anterior tibia

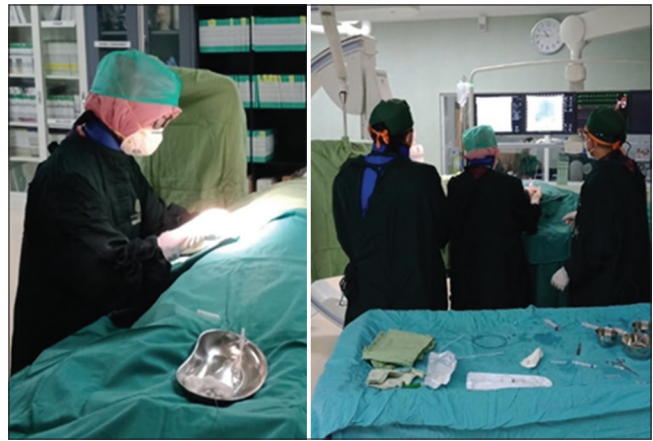


Figure 6: Percutaneous Transluminal Angioplasty was done at cath lab at PKU Muhammadiyah Gamping Hospital

artery and middle of anterior tibia artery (Figure 7b-c). Therefore, the patient carried out PTA therapy to restore distal perfusion.

PTA was done by local anesthesia, which injected in right groin. A guide wire and catheter inserted to femoral artery through introducer sheath. A deflated balloon catheter inserted and pushed forward along the microwire to the site of obstruction at middle of anterior tibia artery (Figure 7e). Our interventional radiology team used angioplasty balloon with 3 mm in wide and 80 mm in length. Then, inflate the balloon to opens up the stenosis or occlusion. After PTA, no stenosis in middle of anterior tibial artery (Figure 7f). PTA wasn't done in proximal of anterior tibia artery because its curved location. Stenosis in proximal of anterior tibia artery was adjacent to the branching of the popliteal artery become tibioperoneal trunk and anterior tibial artery (Figure 7b).

After PTA, general condition of our patient was good. GCS revealed 4-5-6 and vital sign result was normal. 2 days later, peripheral oxygen examination in left digit I, II and V were 98%, 98% and 98%, respectively. Besides that, swollen foot was also diminished. The patient was discharged and advised to control routinely to surgeon, internal medicine and interventional radiology clinics.

Discussion

PAD is defined as vascular disorder which peripheral artery's obstruction or constriction is found. Chronic limb ischemia (CLI) also referred to as CLI (one of the PAD key terms) is clinical finding which there are chronic claudication, foot ulcer and wound that do not heal for a period at least two weeks, which is proven as occlusive artery disease [5], [6], [3]. Initially, atherosclerosis is happened, and then there is decrease blood flow to distal extremities [6]. Proper diagnosis and

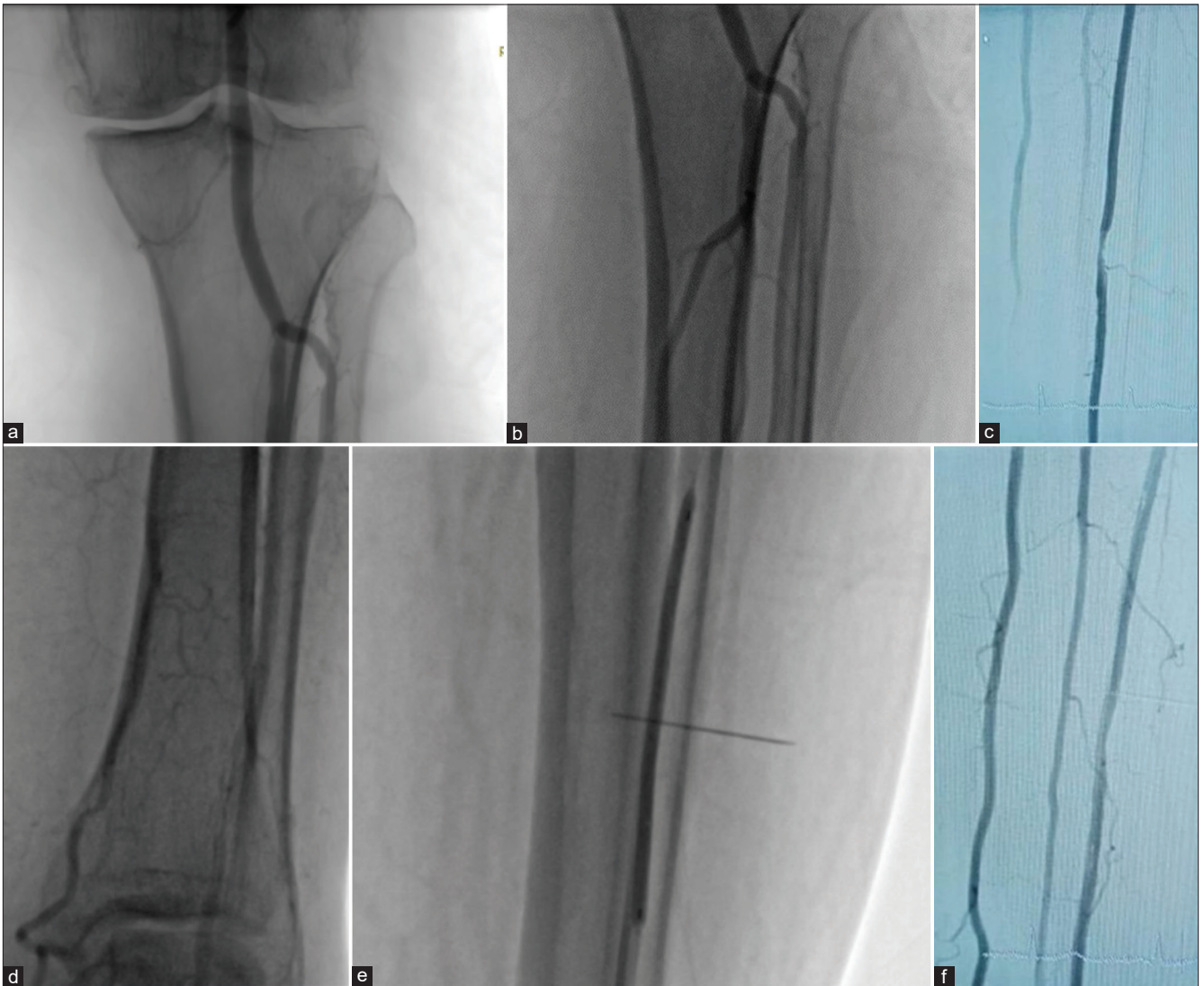


Figure 7: (a). No stenosis in poplitea artery, (b). Partial stenosis in proximal of anterior tibia artery, (c). Partial stenosis in middle of anterior tibia artery (in mid calf in left leg) (d). No stenosis in posterior tibia artery. (e). Inflated balloon in site of stenosis in anterior tibia artery (f). After Percutaneous Transluminal Angioplasty: No stenosis, good flow

appropriate treatment and multidisciplinary approach can improve the prognosis and prevent limb loss or amputation, which impact to quality of life [1], [2], [7].

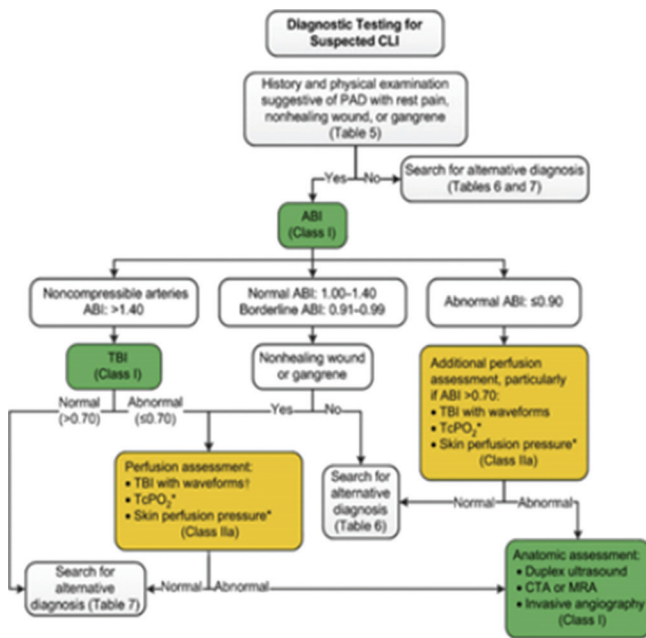
The most severe spectrum of PAD was known by progressive claudication which can develop to nocturnal rest pain [6]. The severity of CLI may be classified into without symptom, claudication, CLI followed by rest pain and CLI followed by tissue damage [5], [9], [13]. It is started with the reduction blood flow to the lower extremities especially for activity, so initial symptom which appears was pain that more severe with activity and less severe with rest. Then, the diameter artery will decrease gradually, therefore blood flow to lower extremity will diminish significantly, particularly when take a rest. So it is often called nocturnal rest pain. Besides that, the pain often more severe at night when the patient is lying down.

Sometimes, diagnosis of PAD can be difficult, especially if ABI value is normal. The sensitivity of ABI is ranging from 68 to 84% and specificities from 84 to

99% [11]. Based on recent medical history, medical history previously and physical examination in our case, diagnosis of PAD is possible, although ABI value is normal. ABI value in this case showed 1.14 at right toe and 1.12 at left toe. ABI in the both of toe were normal.

People with DM has characteristic extremity artery is showed normal ABI value or more than 1,4. Normal ABI value or more than 1,4 reveal that the arteries cannot be compressed. It is often found in people with DM or chronic kidney disease [14], [15]. It is concordance with Park *et al.* that declare that normal or elevated ABI can be caused by sclerosis of the medial wall of lower extremity artery [14]. Therefore, we can conclude that a normal ABI value is cannot exclude PAD in our patients.

If previous predication and lower extremity investigation propound of PAD with ordinary assessment of ABI, is suggested to check extremity perfusion, as referred below in Figure 8 [11]. ABI is not recommended in patients with vascular hardness and cannot find the



AQ1 Figure 8: Diagnostic testing for suspected chronic limb ischemia [5]

early finding of sclerosis artery [14]. In our case, ABI value is normal. TBI is more offered in our case because toe vessels are less susceptible to vascular stiffness [15]. TBI is usually limited to patients who have normal or elevated ABI value or have vessel stiffness caused by relevant comorbidities, especially DM in our case [14], [15].

There are many factors can affect prognosis of PAD patients with diabetes, for example the presence of infection, comorbidity, neuropathy and immunological history of the patient. DM can expedite atherosclerosis process and had a 5–10 times higher amputation risk than people that no had diabetes history [6], [16]. It is caused by its tendency in the distal arteries, so it has correlation with neuropathy finding and higher risk of infection [16].

TBI value in our patient showed 0.5 in left toe. If we concern with Algorithm of Diagnostic Testing for Suspected CLI in Figure 8 above, abnormal TBI will be followed by TBI with wave forms, TcPO₂ and skin perfusion pressure. Unfortunately, all of examination above is not yet available in our hospital. To overcome our limitation of perfusion assessment, we must concern with DUS finding. It can be the sole imaging modality used to guide endovascular procedures, which is give information about level stenosis and physiological severity of a stenosis [17]. According to Hwang (2017), the sensitivity and specificity of DUS in determine narrowing of vascular diameter as less than or greater than 50% are 77–82% and 92–98%, respectively [4], [18].

Normal finding of DUS in lower extremity arteries is defined as an upper pulsatory spectral wave which has triphasic flow pattern [18]. Normal heartbeat flow be composed by a tall, narrow and sharp systolic peak in first phase, then by early diastolic reversal flow in second phase and followed by late diastolic forward in third phase [18], [19]. Normal characteristic of artery

in extremities is high peripheral resistance, so this is will result diastolic reversal flow.

There are many parameters which is we must concern about DUS finding: (1) clear spectral window, (2) spectral narrow/no spectral broadening, and (3) presence of reversal flow [20] (Table 1).

Table 1: Comparison between DUS finding and angiogram finding in our case

DUS finding	Clear spectral window	Spectral narrow	Reversal flow	Angiogram finding
Femoral superficial artery	-	+	+	No stenosis
Poplitea artery	+	+	+	No stenosis
Anterior tibial artery	-	-	-	Partial stenosis
Posterior tibial artery	+	-	+	No stenosis

DUS: Doppler ultrasound

Spectral waveform in superficial femoral, poplitea and posterior tibial artery in our case appear as triphasic pattern. However, monophasic pattern was found in anterior tibial artery. It is concordance with examination by Sibley *et al.* (2017), which declare that loss of vascular resistance in PAD results in the loss of reversal flow, so conduce monophasic pattern [5], [18]. Besides that, we can found no clear spectral window in anterior tibial artery. It means blood cells are moving at different speed or there is turbulence flow within anterior tibial artery in our case.

Based on Table 1, clear spectral window was not too taken effect with angiogram finding. Although there is no clear spectral window in superficial femoral artery, there is reversal flow in it, so it means no stenosis and corresponding with our angiogram result.

Similar with clear spectral window, although there is spectral broadening in anterior tibia and posterior tibia artery, but no reversal flow in anterior tibia artery (partial stenosis in our angiograph) dan there is reversal flow in posterior tibia artery (no stenosis in our angiogram). If we concerned that spectral broadening in posterior tibia artery is not as wide as in anterior tibia artery. According to Hwang (2017), spectral broadening is prominent, with a diameter reduction of 20–50% [18]. Therefore, based on three parameters and our angiogram finding as mentioned above, reversal flow is most important parameter to establish presence of stenosis.

According to Lower Extremity PAD Guideline, if leg symptoms are not found in patient, arteriography is not recommended for determination of presence of limb vascular abnormality, because depiction of anatomy will not establish kind of treatment [5]. In our case, our patient complained about intermittent left calf pain for 7 years, so arteriography was recommended to restore distal perfusion. Besides that, it was corresponding with Thukkani's statement that represent revascularization is typically considered in patients with PAD who had any 1 of 3 diverse clinical finding: (1) ischemic rest pain which get poor response to medical therapy (2) CLI or (3) acute limb

ischemia [11]. The urgency and goals of treatment depend on the clinical syndrome, comorbidities and occlusive anatomic level [7].

Digital subtraction angiography is recommended as the gold standard examination which represent detailed vascular mapping until distal end. Contrast agent is injected through catheter and the flow of contrast filling vasculature will be obtained [5]. PTA is endovascular revascularization, which can be performed in the same circumstances. It is a minimally invasive therapy for the treatment of patients with PAD who suffer from intermittent claudication or CLI. Before PTA, diagnostic arteriography must be done [5]. Arteriography finding was partial stenosis in middle of anterior tibia artery, 4 cm in length of stenosis and 40% in vascular patency. There is no finding of collateral vessels as compensation to stenosis in its upper artery. It was consistent with research of Thulasikumar (2017), which represent the vascular collateral formation in diabetes patient was impaired, so vascular flow to distal tissue became inadequate and then severe ischemia was more happened [4].

In our case, after PTA there was no stenosis again in middle anterior tibia artery. Initial success rates are in the 90% range for PTA of the superficial femoral artery and below of popliteal arteries. However, for a long period of time (5 years), success rate of PTA varied from 53 to 70%, depending on the severity of disease and which diseased blood vessel was treated [21]. According to Robertson *et al.* (2017), the success rate of PTA depends on severity of PAD (intermittent claudication or occlusion), the length of lesion, quality of vessel, concomitant disease and risk factors [8]. Our patient is categorized in chronic limb ischemia, type of PAD was stenosis, no thrombus, 4 cm in the length of lesion, had diabetes in for long times (10 years), vessels tend had stiffness caused by diabetes history. Besides that, our patient had hyperlipidemia and hypertension as risk factor that can affect success rate of PTA. Therefore, further follow-up is needed.

The correlation between dyslipidemia and PAD is in the occurrence of atherosclerosis. Patients with dyslipidemia provide a risk factor for the onset of atherosclerosis. Dyslipidemia manifests with hyperglycemia, excess free fatty acids and insulin resistance which causes increment of oxidative stress, endothelin-1, angiotensin II and platelet activation, deflation of nitric oxide and alleviation of fibrinolysis which all cause endothelium dysfunction [2].

Conclusion

Reversal flow finding in DUS is most important parameter to establish the presence of stenosis. PTA is adequate to give revascularization stenosis in PAD.

More earlier PAD's diagnosis, more earlier PTA is done, so it can prevent limb amputation.

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